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SURVEY REPORT ON SANTA YNEZ RIVER
WATERSHED, CALIFORNIA

LETTER

FROM THE

ACTING SECRETARY OF AGRICULTURE

TRANSMITTING

A REPORT OF A SURVEY OF THE SANTA YNEZ
RIVER WATERSHED IN CALIFORNIA



MARCH 28, 1944.—Referred to the Committee on Flood Control
and ordered to be printed, with illustrations

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LETTER OF TRANSMITTAL

DEPARTMENT OF AGRICULTURE,
Washington, March 23, 1944.

The honorable the SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: There is transmitted herewith a report of a survey of the Santa Ynez River watershed in California, made by this Department pursuant to the Flood Control Act of June 22, 1936.

The report describes an investigation of a program of water-flow retardation and soil-erosion prevention in aid of flood control. A program of this kind, pursuant to the flood control acts, is recommended for installation in the watershed.

We have been advised by the Bureau of the Budget that while there would be no objection to the submission of the proposed report to the Congress, it should be understood that no commitment would thereby be made as to any early financing of a land-use and management program for the Santa Ynez River watershed in California.

Sincerely,

GROVER B. HILL,
Acting Secretary.

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SURVEY REPORT ON SANTA YNEZ RIVER WATERSHED, CALIFORNIA

SUMMARY OF RECOMMENDATIONS

A program of water-flow retardation and prevention of soil erosion in aid of flood control is recommended for the Santa Ynez River watershed under the Flood Control Act of June 22, 1936, Public, No. 738, Seventy-fourth Congress, as amended June 28, 1938, Public, No. 761, Seventy-fifth Congress.

The character, extent, and cost of the program to be installed will depend upon what reservoirs are to be built on the Santa Ynez River for flood control and water conservation. The choice of program should therefore await completion of reservoir plans for the watershed.

PLAN I. PROGRAM TO ACCOMPANY ENLARGED GIBRALTAR OR CACHUMA RESERVOIR, OR BOTH

In the event that Gibraltar Dam is enlarged and no other reservoirs built, or that a dam is built at or near the Cachuma site either with or without enlargement of Gibraltar Reservoir, the following program is recommended:

1. Increased forest-fire control and reseeding of burns as they occur, involving an installation cost to the Federal Government of \$241,000, and an annual operation and maintenance cost to the Federal Government of \$21,800.

2. Structural measures on the tributary channels, supported by land-use measures in areas drained by the channels on the north side of Santa Ynez River from Purisima Canyon to Canada de Laguna. This involves a cost to the Federal Government for installation of \$177,400, and approximately \$320 annually for operation and maintenance of the farm-land measures.

The total Federal cost of this program will therefore be \$425,300 for installation and \$22,500 annually thereafter for operation and maintenance.

In addition to the Federal costs of this program, State or local governments will provide \$3,520 for rights-of-way in connection with the installation of the structures on tributary channels and about \$775 annually for the maintenance of these structures. Farmers will supply approximately \$18,800 annually as the increased cost to them of operating their lands with the measures in effect and of maintaining structural measures.

The flood and sediment reduction benefits of this program will vary according to which reservoirs are constructed. Their average annual value will be approximately as follows:

With Gibraltar Reservoir enlarged and no other reservoir built, \$39,400.

With Cachuma Reservoir constructed and Gibraltar Reservoir unchanged, \$46,250.¹

With Cachuma Reservoir constructed and Gibraltar Reservoir enlarged, \$42,150.¹

In addition to the flood-control benefits this program will provide benefits in the form of reduced fire-suppression cost of \$19,600 annually and in the form of increased farm income of \$86,600 annually. Total average annual benefits will thus be \$145,600, \$152,500, or \$148,400, depending upon which reservoirs are built. This is exclusive of indirect benefits, and of unevaluated benefits from the reduction of flood damages on the main stream below probable future reservoirs.

The average annual cost of the program is approximately \$58,600. The average annual Federal cost is approximately \$37,500.

PLAN II. PROGRAM TO ACCOMPANY A COMBINATION OF SANTA ROSA AND ENLARGED GIBRALTAR RESERVOIRS OR OF SANTA ROSA AND CACHUMA RESERVOIRS

In the event that a dam is built at the Santa Rosa site and Gibraltar Dam enlarged, or reservoirs built at the Santa Rosa and Cachuma sites, and Gibraltar Dam unchanged, the following program is recommended:

1. Increased forest-fire control and reseeding of burns as in plan I, involving a Federal installation cost of \$246,000 and an annual operation and maintenance cost of \$22,170.

2. Farm land treatment plus local structures in areas upstream from Santa Rosa Dam, involving a Federal installation cost of \$40,000 and an average annual cost for operation and maintenance of the farm-land measures of \$730.

3. Structural measures on tributary channels below Santa Rosa Dam, supported by land-use measures along those channels north of Santa Ynez River. This involves a Federal installation cost of \$148,400 and approximately \$225 annually for operation and maintenance of the land-use measures.

The total Federal cost of this program will therefore be \$434,400 for installation and \$23,125 for operation and maintenance.

In addition to the Federal cost of the program State or local governments will provide \$13,400 for installation of the farm land and structural measures, and \$775 annually for the operation and maintenance of structures on tributary channels. Farmers will supply approximately \$90,000 annually as the increased cost to them of operating with the measures in effect and to maintain structures.

¹ Benefits from reducing sedimentation in Cachuma Reservoir are based upon assumed costs for the construction of that reservoir. If actual construction costs differ from the assumed amount, benefits will vary accordingly.

The flood and sediment reduction benefits of this program will vary according to which reservoirs are constructed. Their average annual value will be approximately as follows:

With Santa Rosa Reservoir constructed and Gibraltar Reservoir enlarged, \$48,400.

With Santa Rosa and Cachuma Reservoirs constructed and Gibraltar Reservoir unchanged, \$52,700.

In addition to the flood-control benefits, this program will provide benefits in the form of reduced fire-suppression cost of \$19,600 annually, and in the form of increased farm income, of \$213,600 annually. Total average annual benefits will thus be \$281,600, or \$285,000, depending upon which reservoirs are built.

The average annual cost of the program is approximately \$131,000. The average annual Federal cost is approximately \$38,300.

Actual costs, average annual costs, and average annual benefits of the two programs planned are given in table 1.

SANTA YNEZ RIVER WATERSHED, CALIFORNIA

TABLE 1.—*Costs, direct evaluated benefits, and benefits per dollar of cost for alternative U. S. Department of Agriculture programs, Santa Ynez watershed*

SANTA YNEZ RIVER WATERSHED, CALIFORNIA

Below Santa Rosa Dam:								
Farm land	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330
Structural measures	147,108	3,520	150,628	5,273	47	226	623	13,800
Subtotal								990
Total								1,613
Plan 2 with Santa Ross and Cachuma Dams constructed; Gibraltar Dam unchanged:								
Above Santa Rosa Dam:								
Forest land ¹	245,885	245,885	8,606	22,171				22,171
Farm land	9,720	9,922	19,642	687	730		74,808	75,538
Structural measures	30,317		30,317	1,001			288	421
Subtotal							163	1,214
Below Santa Rosa Dam:								
Farm land	1,330	1,330	1,330	1,330	1,330	1,330	1,330	1,330
Structural measures	147,108	3,520	150,628	5,273	47	226	623	13,800
Subtotal								990
Total								1,613
434,360	13,442	447,802	15,674	23,127	776	89,866	113,769	41,057
								130,923

¹ To obtain the average annual equivalent of values which occur at other than uniform annual intervals, costs due or benefits accruing each year are discounted to the present, added and multiplied by the discount rate. The rate used throughout was 3½ percent.

² Junal Reservoir is included in all calculations for Gibraltar Reservoir.

^a Cost of forest land program for entire watershed is compared with benefits of sedimentation prevention in individual drainage areas.

SANTA YNEZ RIVER WATERSHED, CALIFORNIA

TABLE 1.—*Costs, direct evaluated benefits, and benefits per dollar of cost for alternative U. S. Department of Agriculture programs, Santa Ynez watershed*—Continued

Below Santa Rosa Dam:								
Farm land								
Structural measures								
Subtotal								
Total								
Plan 2 with Santa Rosa and Cachuma Dams constructed; Gibraltar Dam unchanged:								
Above Santa Rosa Dam:								
Forest land								
Farm land								
Structural measures								
Subtotal								
Below Santa Rosa Dam:								
Farm land								
Structural measures								
Subtotal								
Total								

¹ To obtain the average annual equivalent of values which occur at other than uniform annual intervals, costs due or benefits accruing each year are discounted to the present, added and multiplied by the discount rate. The rate used throughout was 3½ percent.

² Junca Reservoir is included in all calculations for Gibraltar Reservoir.

³ Cost of forest land program for entire watershed is compared with benefits of sedimentation prevention in individual drainage areas.

INTRODUCTION

Large floods occur in the Santa Ynez watershed on the average of once every 16 years and smaller floods once every 7 years. Heaviest damage occurs in the Lompoc Valley in which is concentrated most of the highly productive cropland in the watershed. Other localized damage areas are of minor importance.

In the Lompoc Valley some 85,000 acres of high-value irrigated land and the improvements thereon are subject to damage. Within the past 70 years more than 1,000 acres of this land has been totally destroyed and many times this acreage has suffered partial damage. In addition to this land damage, crops valued at several hundred dollars per acre have been hard hit.

Closely linked with the flood problem in the Santa Ynez watershed is the problem of water conservation. At the present time Gibraltar and Juncal Reservoirs, with a combined capacity of approximately 15,000 acre-feet, provide the only water storage in the watershed. The need for additional storage facilities for water supply and irrigation uses is great. Gibraltar Reservoir, which provides the water supply for the city of Santa Barbara, is already inadequate for this purpose, and this city now has under consideration plans for increasing the capacity of its water supply system. The Bureau of Reclamation and the United States Engineer Department have under way surveys for the purpose of formulating a program in the interest of water conservation and flood control in the Santa Ynez watershed. It now appears reasonably certain that their final plans will favor the construction of one or more reservoirs. The exact location and size of these reservoirs and the degree of flood control to be provided are not yet known.

Very few good reservoir sites are available on the Santa Ynez River. Those receiving most favorable consideration in the plans of the Bureau of Reclamation and the United Engineer Department are (1) the Tequepis or Cachuma site, and (2) the Santa Rosa site below Buellton. An additional possibility is the enlargement of the present Gibraltar Reservoir. Installation of one or a combination of these reservoirs appears reasonably certain. When installed, flood damages in Lompoc Valley will at least be substantially, if not entirely, eliminated, depending upon what plan will be used in operating the reservoirs. Because of the strong probability that reservoirs will be used to control floods on the lower flood plain, calculation of the probable effect of land treatment in reducing lower main stream flood damages in the absence of reservoirs was not undertaken.

A major problem in providing flood control and water conservation by means of reservoirs in the Santa Ynez watershed is the loss of storage capacity through sedimentation. For example, the Gibraltar Reservoir lost 42 percent of its total storage capacity in 21 years, or at the average rate of 2 percent each year. Additional reservoirs located further downstream will in time be subjected to even heavier sedimentation damage.

It is an established fact that the sediment contribution from poorly managed and abused lands greatly exceeds that from well-managed and protected lands. In the Santa Ynez watershed denuding forest fires on areas of highly unstable soils, followed by heavy rains, have resulted in annual sedimentation rates approaching 100,000 cubic yards per square mile of affected area.

The program in the interest of flood control planned and recommended by the Department of Agriculture is intended to complement the programs of the United States Engineer Department and the Bureau of Reclamation. Through the intensification of fire control and the improvement of cover on forest lands, it is proposed to reduce materially the rates of erosion and sediment contribution of these lands, thus protecting and prolonging the useful life of structures provided by these Federal agencies. The cost of providing and maintaining these measures is amply justified by the benefits derived from reducing sedimentation in these reservoirs. In addition, local measures are proposed for installation in certain minor tributary watersheds to alleviate damages that would not be affected by main stream reservoir construction.

As it is not definitely known at this time which reservoirs will be built and when they will be built, in order to evaluate the proposed program of the Department of Agriculture it has been necessary to assume that reservoirs will be built at one or more of the several alternative sites. Thus plans and evaluations were made for use in connection with five possible dam installations as follows:

1. Gibraltar Dam enlarged.
2. Cachuma Dam constructed; Gibraltar Dam unchanged.
3. Cachuma Dam constructed; Gibraltar Dam enlarged.
4. Santa Rosa Dam constructed; Gibraltar Dam enlarged.
5. Santa Rosa and Cachuma Dams constructed; Gibraltar Dam unchanged.

Two alternative plans of treatment are recommended by the Department of Agriculture. The first plan would be installed if reservoir combinations 1, 2, or 3 are constructed; the second if reservoir combinations 4 or 5 are built.

The approach of the Department of Agriculture to the flood problem in the Santa Ynez watershed recognizes that the problem in the lower main reaches of the valley can be sufficiently remedied only by a program involving the installation of major flood control and water-conservation reservoirs. The program planned and recommended by the Department of Agriculture is for the purpose of complementing the reservoir construction program. It will be necessary, therefore, at the time that the reservoir program is finally determined, to select and put into effect from among the several programs described in this report that program which will fit in best with the plans of the other interested agencies.

DESCRIPTION OF THE WATERSHED

LOCATION AND SIZE

The Santa Ynez River watershed, 900 square miles in area, is situated in Santa Barbara County, Calif., about 100 miles north and west of Los Angeles. The watershed is roughly rectangular in shape, with an east-to-west length of about 68 miles and a north-to-south width averaging 14 miles. The boundaries are well defined on the north by the Purisima Hills and by the San Rafael Mountains rising to elevations of more than 6,500 feet, and on the south by the Santa Ynez Mountains, which reach elevations slightly over 4,000 feet. These two mountain ranges converge on the east in a rugged mountain

block which forms the headwaters of the Santa Ynez River, and from which the river flows westerly to enter the Pacific Ocean north of Point Arguello. (Map 1.)

TOPOGRAPHY AND CLIMATE

The watershed comprises three physiographic types—lowlands, foothills, and mountains—containing roughly 10, 20, and 70 percent, respectively, of the drainage area. The lowlands include flood plains near the mouth of the river, the central Santa Ynez Valley and the low rolling hills below the 500-foot contour bordering the lower 50 miles of the river. The foothills include the areas of moderate relief bordering the valleys between elevations of 500 and about 1,500 feet. The mountains occupy the eastern third of the watershed and extend westward along its borders to within a few miles of the river mouth. The eastern portion is characterized by rugged relief and elevations upward to 6,800 feet.

Tributaries entering the Santa Ynez River from the south side are from 6 to 10 miles long, while those on the north side are from 10 to 20 miles long. Their gradients are steep, averaging from 2 to 6 percent, but reaching 50 percent in some instances. In the upper half of the watershed the gradient of the main stream averages 2 percent, but in the lower part it is only 0.25 percent.

Mean annual precipitation varies from less than 15 inches in the lower watershed to more than 35 inches at the higher elevations. Seasonal range in precipitation is from 5 to 30 inches in the lower watershed, and from 15 to 75 inches in the upper. For the most part the precipitation is rain, and intensities of 2 inches or more an hour often occur. Ninety percent of the seasonal precipitation comes in the period November 1 to April 30, while flood occurrences are very largely restricted to the months December to March, inclusive, in which 75 percent of the seasonal precipitation occurs. In the higher mountains there are occasional snowstorms in winter and thunder-showers during the summer, but these have no appreciable bearing on the flood problem.

The climate is of the Mediterranean type characterized by long dry summers and mild winters. During the dry season the humidity drops very low in the central and upper parts of the watershed, with temperatures often above 100° F., but in the lower area near the coast summer fogs are regularly experienced. In the fall, strong dry continental winds from the north often blow across the watershed for 2 or 3 days at a time.

GEOLOGY AND SOILS

In the lower Santa Ynez watershed many soils types have been mapped, but for the purposes of this survey these were combined into six groups. According to origin, texture, and profile characteristics, these groups are: Light- and heavy-textured alluvial soils with little or no profile development, light- and heavy-textured alluvial soils with strong profile development and impervious substrata, and light- and heavy-textured residual soils. In the mountain areas where soils are comparatively shallow, they are grouped according to infiltration capacity, erodibility, and rate of soil formation. These five mountain



LEGEND

- Watershed Boundary
- Reservoir or Debris Basin & Dam
- City or Town
- Railroad
- U.S. Main Motor Highway
- State Other
- River & Creek Courses
- Washes
- Los Padres Nat'l Forest Boundary
- County Boundary
- Army Reservation Boundary
- Water Supply Tunnel
- Subwatershed Boundary
- Lookout



MAP-1
SANTA YNEZ RIVER WATERSHED
CALIFORNIA

SCALE

0 1 2 3 4 5 6 7 8 9 10 Miles

soil groups include: Franciscan shales and basalts, Knoxville shales, upper Cretaceous and Tertiary sandstones and shales, Miocene siliceous shales, and Pliocene sandstones and semiconglomerates.

Both topography and geology of the watershed have been strongly affected by fault action. The major streams have carved their channels along fault zones, while frequent earth movements have deeply shattered the rock formations.

LAND COVER

According to their effect on run-off, 12 major vegetation cover types have been delineated for flood-control purposes in the Santa Ynez River watershed. These include barren areas, semibarren areas, grassland, dry-farmed cropland, irrigated cropland, sagebrush, sage-grass, chamise chaparral, mixed chaparral, woodland-grass, oak woodland, and stands of miscellaneous conifers.

Barren areas include rock outcrops, water surfaces, paved urban areas, and road surfaces. Although limited in extent they are significant because over 95 percent of the precipitation which reaches them escapes as run-off. Together with the semibarren areas, in which vegetation covers less than 30 percent of the ground surface, the total area is about 1 percent of the watershed.

Grassland includes areas on which the principal cover consists of annual grasses or other herbaceous vegetation. Abandoned cultivated land is considered in this type because it customarily reverts to a grass and weed cover. Total area of the type is about 15 percent of the watershed.

Cultivated land, including temporarily idle and fallow land, covers about 11 percent of the watershed. Irrigated land is located primarily in the broad valley about Lompoc, in a narrow strip along the Santa Ynez River to Solvang, and in a few scattered areas in the Santa Ynez Valley and along Zaca Creek. Nonirrigated land occupies small areas on the gentler side slopes along the tributaries to the river, the largest being in the vicinity of Santa Ynez and Santa Rita. There is practically no cultivated land in the upper half of the watershed.

The sage type includes areas with a cover principally of *Salvia* species and occupies about 3 percent of the watershed. This type occurs at the lower elevations intermixed with grassland, and has a rather low infiltration capacity.

Sage-sagebrush-grass includes species of *Salvia* and *Artemesia* as dominants, together with various grasses. The type covers some 14 percent of the watershed and is scattered throughout the entire area.

Chamise chaparral, including those areas on which the principal dominant species is *Adenostoma*, occupies about 15 percent of the watershed. Infiltration rates for soils supporting chamise cover are very low; stand density is low, and litter production is poor.

Mixed chaparral is characterized by such dominants as *Ceanothus*, *Arctostaphylos*, and *Quercus*, together with other species of similar growth form. Stands tend to be quite dense; litter production is good, and infiltration rates are relatively high. This type covers 29 percent of the watershed.

The woodland-grass type is intermediate between grassland and oak woodland, being typically composed of oak and pine trees quite widely spaced with unbroken grass cover between. It occupies seven percent of the watershed, mainly in the upper and central portions.

Oak woodland, composed of dense stands of broad-leaved trees, is distributed quite widely over the entire watershed, covering some 4 percent of the area. The type is generally confined to northerly exposures and stream bottoms where the supply of soil moisture is sufficient for dense growth. The soils are deep, and infiltration rates are high.

Stands of miscellaneous conifers, usually with an undergrowth of shrubby vegetation, occupy 1 percent of the watershed and are found on the uplands or on riparian sites. Principal components of the type are various species of pine and big-cone Douglas fir.

FLOOD HISTORY

Beginning with the first recorded flood in 1862, the history of the Santa Ynez River watershed records 6 major floods during the period of record, namely those of 1862, 1884, 1907, 1914, 1915, and 1938, and 11 floods of lesser magnitude. Other smaller floods have caused damage in exposed parts of the lower watershed. The flood of January 1907 is believed to have been the largest experienced, though the greatest damage was done by that of March 1938.

Floods of magnitude sufficient to cause extensive damage throughout the watershed are estimated to have a frequency of 5 in 100 years, while the lesser floods are estimated to occur 15 times in 100 years.² Detailed damage records, however, are available only for the flood of March 1938.

Past flood occurrence has been confined to the 7 months from October to April, inclusive, with the great majority coming during the winter months December to March. Peak occurrence is in the months of January and February.

ECONOMIC DEVELOPMENT

EARLY SETTLEMENT AND DEVELOPMENT

With the founding of Purisima Mission in 1787, settlement of the Lompoc area began. Shortly afterward, in 1804, establishment of the Santa Ynez Mission opened that area also to agricultural use. From this time through the period of secularization of mission holdings and the Mexican land grants, cattle grazing constituted the main enterprise of the watershed. The great drought of 1862-63 brought this early period to a close. With almost complete destruction of the cattle industry, many of the grants were subdivided and sold to American settlers. With this event clearing of the Lompoc Valley began, and soon afterward the hill and tributary valleys were put to the plow. As a consequence the reviving cattle and sheep industry was pushed back into areas unsuited for crop agriculture. With the laying of the Southern Pacific Railroad tracks to Santa Barbara in 1887, the general pattern of modern agricultural use was well on its way to being established. Introduction of widespread irrigation during the years from 1910 to 1930 changed the pattern of agriculture to its present form.

See appendix 3. Not printed.

POPULATION AND URBAN DEVELOPMENT

The total population of the Santa Ynez River watershed was given as 7,230 people at the 1940 census. Of this total number about 4,500 lived in urban communities, even though the greater part of the population is dependent upon agricultural pursuits. Since the construction and occupation of Camp Cooke in 1941, the number of people, especially in and around Lompoc, has increased greatly. Lompoc is the only incorporated town in the watershed. It was founded in 1874, and at the time of the last census had a population of 3,379 people. Other communities in the watershed are Solvang, Santa Ynez, Ballard, and Los Olivos, all situated in the lower Santa Ynez Valley, and Buellton. Solvang, with about 400 people, is the largest of these communities. With the exception of Buellton, none of the towns is located on a trunk highway and only a spur of the Southern Pacific Railroad connects Lompoc with the main line. None of the urban developments is threatened by floods from the Santa Ynez River.

LAND OWNERSHIP AND USE

The Santa Ynez River watershed embraces 576,000 acres, of which 347,318 acres are in private ownership and 223,317 acres are federally owned. Federal lands are in Los Padres National Forest except for 1,650 acres of unappropriated public domain and 87 acres of Indian reservation. State-owned land representing parks amounts to 648 acres, county land to 75 acres, and school land to 42 acres. In addition, 4,600 acres are municipal property, comprising the areas surrounding mountain reservoirs belonging to the cities of Santa Barbara and Montecito.

The mountain land, mostly within the national forest, is reserved for watershed purposes and to a limited degree for recreation and grazing. Of the privately owned land, 89,165 acres are wild land and a small acreage urban properties and roads. The greater portion of private holdings, embracing some 258,153 acres, is used for agricultural pursuits. Irrigation farming occupies 13,311 acres, dry-land farming 52,342 acres, and grazing 192,500 acres. Approximately 17,500 acres of national forest range land are grazed under permit from the Federal Government.

The irrigated land is restricted at the present time to areas with available water from underground basins and perennial streams. These areas extend throughout the Lompoc Valley, along the Santa Ynez River to the east of Solvang and scattered places in the Santa Ynez Valley. Vegetables, sugar beets, flowers, and alfalfa are the major irrigated crops. Wherever growing conditions are favorable for alfalfa, dairying is well established. Dry-land farming occupies the gentle slopes and tributary valleys on both sides of the river and most of the Santa Ynez Valley. Beans, mustard, grain, and hay are extensively grown. The steeper hills and other rough land in the lower portion are utilized for cattle grazing, which is still one of the major income producing industries of the watershed.

Mining in the Santa Ynez River watershed is restricted to a few quicksilver mines near Gibraltar Reservoir and the Cachuma Gap. Diatomaceous earth deposits are located in the hills south of Lompoc, and large amounts are removed each year. A minor oil field north of Lompoc also adds somewhat to the total income produced within the watershed.

LAND UTILIZATION AND FLOOD PROBLEMS

RUN-OFF AND EROSION PROBLEMS IN RELATION TO LAND USE

*Farm land.*³—The farm land is located almost entirely in the lower half of the watershed adjacent to the communities of Lompoc, Buellton, Santa Ynez, and Solvang, centering in the Lompoc and Santa Ynez Valleys. Although about 65,000 acres or 11 percent of the watershed area is cultivated, only the cropland in subwatersheds B and C, aggregating approximately 45,000 acres or 8 percent of the total watershed area, is so located that it contributes significantly to flood damage.

Of the contributing 45,000 acres, approximately 41,000 acres are dry-farmed and 4,000 acres irrigated. The dry-farmed area is most significant to the flood-control problem because of its greater extent and location on more steeply sloping land.

Existing problems on agricultural land grow out of a long history of exploitive cropping practices and cultivation without regard to conservation.

The effects of extensive cultivation and heavy grazing of the hill land became evident in the form of accelerated run-off and erosion. Heavy rains in 1910 and 1914 cut large gullies in the valley bottoms, initiating a cycle of severe erosion that has destroyed some agricultural land, made other acreage inaccessible and carried erosion debris downstream to cause damage through sedimentation. The gullies so started have grown with the passing years until some 400 acres of land have now been destroyed.

The process of destruction was lent impetus by the high farm prices that prevailed during World War I. During that period virtually all the land that could be plowed was brought under cultivation, including slopes of 40 percent gradient and steeper. Some of the land that was retired because of decreased yields and unprofitable operation resulting from site deterioration is again being cultivated because of current (1942) higher prices for the crops.

Crops raised in the watershed at present are governed strongly by topography and availability of water. Grain and grain hay, beans, vegetables, sugar beets, mustard, alfalfa, corn and sorghum, and flower seed are the principal crops grown, listed in order of the 1937-40 acreage planted. Vegetables, sugar beets, alfalfa, and flower seed predominate under irrigation on the alluvial valley fills. Dairying is found wherever alfalfa culture is successful. On alluvial fills along the creeks where water is limited, and on the hill lands that must be dry-farmed, beans, grain, grain hay, and mustard predominate.⁴

Yields on the valley land are generally excellent, but the hill land affords only a bare existence to the farmer. Destruction of the valley

³ For details by individual areas within the watershed see appendix 4.

⁴ For further details see appendix 4.

land by erosion would make the whole area submarginal for present crops, and would force more areas into range and grazing use. If this should occur, the number of people finding support in the region would be considerably reduced.

Among detrimental farming practices are the utilization of steep slopes, clean cultivation, cultivation parallel to the direction of run-off—that is, up and down the slope—and a general failure to return nutrients to the soil in the form of crop residues or fertilizer.

The existing practice of short-term crop-share leases has materially aggravated the conditions on dry-farmed land. Such leasing provisions foster exploitive use of the land because the tenant has little security in the continuance of the operations and little to gain from installing conservation methods of farming.

Range land.—Closely associated with the problems of farm land are those of the range land. The chief problems on range land are widespread soil compaction and local overuse. Both problems arise from the system of extensive management under which grazing is now practiced. Problems of less importance are erosion and the deterioration of range vegetation.

Soil compaction is present to a significant degree on approximately 82,000 acres of the range land throughout the watershed. Of this area about 76,000 acres lie in subwatersheds B, C, and D, so located that they contribute excessive run-off to the major flood damage area around Lompoc. Over-use occurs on some 4,000 acres of range land in subwatershed C. Subwatershed A is excluded because of its position downstream from the area of significant flood damage, and no range problem exists in subwatershed E. (Map 1, facing p. 10.)

Range use in the watershed dates back to 1787 when La Purisima Mission was founded near the present city of Lompoc. In the early days, heavy grazing and years of drought acted together to destroy the native perennial grass cover. The perennials were replaced, however, by annual grasses introduced largely through seed carried by the livestock that were shipped in, often from foreign lands. The result has been conversion to an annual grass type of range, the introduced species having become established and widely naturalized. Due to the hardiness and other characteristics of this annual cover, range lands of the watershed are still in comparatively good condition with regard to the erosion and gullying.

The principal livestock enterprises carried on in the watershed include beef cattle feeding and breeding and the maintenance of dairy herds. Most of the beef cattle in the watershed are brought in as weaner calves or yearlings and sold after one or two grass seasons. Breeding of purebreds is confined to relatively few ranches, although most ranches maintain breeding herds. The present trend is toward increased interest in breeding cattle, although Santa Barbara County is known as a stocker type of range. Dairies in the watershed produce both market milk and manufacturing milk.

Horses are relatively few in number and are kept mainly for riding and breeding purposes. Sheep, goats, and hogs are not significant to the range problem, since they are few in number and are grazed on pastures of small acreage.

Of the 210,000 acres of usable range in the watershed, about 190,000 acres, or 90 percent are privately owned. In Los Padres

National Forest, 17,500 acres of forest land are grazed in eight allotments. Some 4,000 acres in mountainous subwatershed E are closed to grazing use because of extremely high fire hazard.

Privately owned grazing units vary in size from a few hundred acres to 37,000 acres. The average size of the ranches in subwatershed B is under 2,000 acres, and in subwatersheds C and D, about 4,000 acres. The 37,000 acre ranch is located in subwatershed D.

It is estimated that grazing capacity is adequate to maintain the present number of livestock without range abuse if intensive management is practiced. Under the present system of extensive management, livestock numbers cause over-use of the range in one part of subwatershed C, while local areas of over-use are distributed throughout the range areas.

Average numbers of livestock expressed in animal units are estimated from the census and local sources at 14,744 units (18,400 head) of beef cattle; 3,701 units (4,400 head) of dairy cattle; 1,500 units (2,000 head) of horses and mules, and 500 units (2,500 head) of sheep and goats, a total of 19,345 animal units, or 27,360 animals.

Rodents and predators do not constitute a problem because of the control programs that are carried on by State and county agencies. Livestock losses due to the flooding of bottom lands are negligible, since the cattle on this type of range have direct access to hillside pastures.

Forest land.—Wild land, of which there is more than 300,000 acres in the Santa Ynez River watershed, is for the most part under the jurisdiction of Los Padres National Forest. Its primary values are for water supply and recreation purposes. It is significant in the flood problem because it occupies the areas of roughest topography, receives the greatest precipitation, and contributes most of the river run-off.

Water supplies for the communities of Montecito and Santa Barbara are derived from the wild land of the upper quarter of the watershed above Gibraltar Dam. Wild land areas are also the most important source of waters for recharging underground basins in the Santa Ynez and Lompoc Valleys.

Erosion from the wild land is important because the debris contributed to stream channels tends to bulk flood flows, increases low-land sedimentation damage, accumulates in water supply reservoirs and limits the usability of water in periods of high flow. In this watershed the normal, or geologic, erosion rates are comparatively low. In spite of rugged topography, unstable and erodible rock formations, and occasional high-intensity rains, these normal rates are estimated at well below 1,000 cubic yards per square mile per year. However, according to records of sedimentation in Gibraltar Dam for the past 20 years, the average rate has been about 3,000 cubic yards per square mile per year because of excessive burning of the watershed cover. It is estimated that under complete denudation the rate would approach 40,000 cubic yards per square mile per year.⁵

Infiltration rates into the soil and delivery of storm waters from the slopes of the watershed are also adversely affected by fire. Bare soil, on denuded slopes open to the beating effects of rain, becomes sealed and percolation of surface water is inhibited. Surface run-off

⁵ Relation of fire to erosion is discussed in appendix 3, siltation of reservoirs in appendix 3.

is increased, and streamflow peaks become much greater than from slopes covered with vegetation. Regulating effects of good watershed cover on streamflow are indicated by comparison of flood peaks for similar storms under varying conditions of the watershed.

Roads.—In the Santa Ynez River watershed, roads and highways suffer more flood damage than they cause. Though road fill erosion may contribute to sedimentation problems, and road drainage to local erosion problems, the effect for the watershed as a whole is negligible.

During any wet year, roads suffer damage from deposition and from erosion of berms and overcast slopes. Such damage is, however, taken care of by normal maintenance activities of the agencies responsible for the roads. In times of major flood, bridges are destroyed and sections of road washed out or buried with erosion debris.

Channels.—Stream channels in the extreme upper watershed are in some cases choked with boulders and gravel which are moved downstream by major floods. In most of the watershed, however, erosion debris is of small size, low specific gravity, and limited quantity, and is readily carried to the ocean. In the central and lower watershed the river has been widening in recent times, but in the period since the valleys were first settled, there have been no indications of significant change in channel depth.

However, a considerable portion of the flood damage has been caused by the cutting away of large areas of agricultural bottom land, or by the deposition of sterile sands on these bottomlands. The Lompoc Valley formerly was a marshy flood plain with a poorly defined channel to the ocean, and the river still sweeps the entire lower valley during flood flows.

FLOOD DAMAGES

Accurate records of flood damages along the Santa Ynez are available only for the storm of March 3, 1938. This storm caused a discharge of approximately 50,000 cubic feet per second and inundated a large part of the Lompoc Valley in addition to small exposed areas all along the river. Direct and indirect damages amounted to \$340,000. The losses were caused largely by the destruction of crops and crop-land, injury to farm and residential improvements, and damage to bridges, roads, and utilities.⁶

The heavy rains of the winter 1940-41 caused extensive damage in tributary areas with only minor damage to exposed areas along the Santa Ynez River. Total damage to crops, land, and roads from the three major storms during January to March of that year aggregated more than \$70,000.

Information on floods prior to 1938 is too fragmentary to give a complete and accurate picture of losses suffered. Reports on these floods stress the repeated overflow of the entire Lompoc Valley west and north of Lompoc with every large flow, and flooding of the area marginal to the river and the extreme western part of the valley by smaller flows. Damage in all cases was predominantly to agricultural properties and bridges. However, the spur line of the Southern

⁶ Damages are treated in detail in appendix 3.

Pacific Railroad, roads, rural residences and other improvements have suffered from the swift flows through the valley. The type of damage uppermost in the minds of farmers is the continuous loss of farm land adjacent to the river. Since 1875 approximately 1,000 acres were lost in that manner. Large sums spent by farmers and the county to prevent such losses have been almost entirely in vain, and this type of farm land destruction still continues.

Damages in tributary areas are also considerable. Damage from canyons debouching upon the southern side of Lompoc Valley has been estimated at \$120,600 for a 50-year period, or \$2,412 average annually. This damage would result from storms of sufficient magnitude to overtop the now existing artificial channels.

In the area between Lompoc and Buell Flat north of the Santa Ynez River, flows from numerous canyons are destroying the narrow strips of cultivated land along the creeks and at the mouths of the canyons. Damages in the form of bank erosion, cropland sedimentation and road deposition have been estimated to average \$13,630 a year.⁷

SEDIMENTATION DAMAGES

Erosion and sedimentation rates in the Santa Ynez watershed have been materially increased by the activities of man. Denudation by forest fire, cultivation of hill land, and heavy range use combined to cause great increases in erosion and sedimentation rates as well as in flood run-off. It is estimated that erosion in the watershed may cause soil losses that range from insignificant quantities on stable areas to amounts as great as 100,000 cubic yards a square mile a year on watershed land freshly denuded by fire. The average rate of erosion during the past 20 years on chaparral-covered mountain land, for all drainages calculated with consideration of fire history, road construction and other causes of denudation, is estimated at about 3,000 cubic yards per square mile per year. On grassland used for grazing in the mountain area, the average annual erosion loss is estimated at about 400 cubic yards per square mile. Rates of soil loss from farm land are apt to be much higher due to the soil disturbance attendant on cultivation. These quantities range from insignificant amounts on level well-managed bottom land to as much as 8,000 cubic yards per square mile each year on the more steeply sloping land.

Installation of the Gibraltar water supply reservoir in 1920 and the Juncal water supply reservoir in 1930 has pointed up existing erosion problems. The great bulk of debris removed from the mountain land has been deposited in these reservoirs.

Original capacity of the Gibraltar Reservoir was 14,500 acre-feet; in 1941, twenty-one years after construction, it had a capacity of only 8,390 acre-feet. The present capacity is almost too small to provide a sufficient water supply reserve for the city of Santa Barbara during a period of dry years. Deterioration of the water-shed has increased storm run-off and shortened the duration of flow into the reservoir. As the Santa Ynez River is the principal source of water supply for the city, the problem is becoming so critical that enlargement of the existing dam or the construction of a new one is necessary.

⁷ Detailed discussion in appendix 3.

Two debris dams have already been built to reduce the rate of siltation in Gibraltar Reservoir. The first, located on Mono Creek, was completed in December 1936 and the second, located on Agua Caliente Creek, was completed a year later. The combined storage space of these debris basins amounted to 1,100 acre-feet. Mono Basin was filled with debris during the second winter after its construction and in November 1941 only 15 acre-feet of storage space remained in the Caliente Basin.

The problem in Juncal Reservoir is less serious because of the small contributing watershed and relatively large storage capacity, although the average debris yield from each square mile of drainage area is about the same as in the Gibraltor watershed. The original 1930 capacity of Juncal was 7,230 acre-feet, its 1941 capacity 6,862 acre-feet.

EXISTING AND PROPOSED FLOOD CONTROL WORK OF ALL AGENCIES

Seven Federal agencies and several local agencies are engaged in activities that are concerned with flood control and water conservation problems of the Santa Ynez River watershed. Federal agencies making flood control or water conservation investigations are United States Engineer Department, Bureau of Reclamation, Geological Survey and Forest Service. Federal agencies whose continuing work has a bearing on the problems of flood control and conservation are Soil Conservation Service, Forest Service, Agricultural Extension Service, and Agricultural Adjustment Agency.

Local agencies developing plans for flood control and water conservation include Santa Barbara County, city of Santa Barbara, city of Lompoc, Montecito County water district and the Santa Ynez Valley water conservation district.

Structural work already completed consists of two water conservation reservoirs and two debris basins in the upper watershed, and minor bank protection structures in the lower river channel. Gibraltar Reservoir, constructed in 1920 at a cost of \$900,000, stores Santa Ynez River water for diversion to Santa Barbara through a mountain tunnel which cost \$400,000. The Juncal Reservoir system built in 1930 at a cost of \$1,400,000 for dam and tunnel, provides water from the upper Santa Ynez River to Montecito. Debris catchment dams in Mono and Caliente tributaries were constructed in 1936 by the Civilian Conservation Corps under direction of the Forest Service to prevent excessive sedimentation in Gibraltar Reservoir from areas denuded by fire in 1932 and 1933.

Water conservation and flood control dams are now being considered for construction on the Santa Ynez River by the Bureau of Reclamation and the United States Engineer Department. Among those investigated are (1) a water conservation dam at or near the present Gibraltar Dam, (2) a dam at the Cachuma or Tequepis site primarily for water conservation but probably having some additional flood control capacity, and (3) a flood control dam at or near the Santa Rosa site below Buellton, possibly having some water conservation capacity.

REMEDIAL PROGRAMS PROPOSED BY THE DEPARTMENT OF AGRICULTURE

PLAN I

Plan I is recommended for installation in the event reservoir storage is provided according to any of the following arrangements:

1. Gibraltar Dam enlarged and no other storage-reservoir built.
2. A dam constructed at the Cachuma site and Gibraltar Dam unchanged.
3. A dam constructed at the Cachuma site and Gibraltar Dam enlarged.

Plan I consists of two parts: (1) Additional fire control and cover improvement measures on the forest land and (2) structures to reduce local damages caused by tributary streams northeast and southwest of Lompoc, supported, in the area northeast of Lompoc, by land use measures.

The benefits from part 1 of this plan will vary according to which combination of reservoirs is adopted.

1. Measures on forest land.

The forest program involves two lines of treatment: (1) Intensified fire control for protection of cover; (2) cover improvement by the sowing of future burns to reduce erosion. Additional protection from fire is recommended for 240,000 acres inside Los Padres National Forest and 50,000 acres outside the forest at present protected by Santa Barbara County. Mustard will be sown on burns of 1,000 or more acres as they occur.

Fire control.—In the last 9 years no big fires have affected the watershed, and cover conditions with respect to regulation of run-off and erosion are gradually improving. However, as the cover improves from year to year, the increased volume of vegetation fuel tends to increase the fire hazard. To safeguard the present gains against the probability of a major conflagration, installation of the proposed additional protection is necessary as the present protection organization is not strong enough to cope with every eventuality.

Standards of fire protection adequate for flood control and attainable within practical limits of manpower, equipment, and cost require reducing the size of the largest expected single burn in 100 years from about 90,000 acres to about 12,000 acres and reducing other burns to the point at which the total reduction will bring the average annual burn from its present rate of 2 percent of the protected area to 0.2 percent.

To attain those objectives, it is proposed to reduce the number of fire starts in the watershed through intensive fire prevention. The plan provides for complete closure of the high danger areas during the dry season. It also provides for regulation of use on other areas which contribute to the fire problem. While primary emphasis is placed on prevention, presuppression activities play an important role in the new program.

Prevention measures include, in addition to the important automatic closure during periods of high risk and hazard, (1) aggressive action on all fires, (2) contacts by protection officials with sportsmen

and other forest users to obtain their recognition of the fire problem and active support of the protection program, and (3) arrangements with ranchers, miners, and others to reduce incendiарism and the danger from burning brush. Other provisions involve extension of national forest boundaries to include high risk unreserved and unappropriated public-domain lands, extension of the forest-protection area of the Federal Government to include the entire high-hazard zone of the upper and central watershed, and acquisition of 2,000 acres of private holdings inside the forest, where fire danger is seriously increased by lack of adequate public control.

Systematic preparedness under the proposed plan provides for employment by the Forest Service of additional men for the regular protection force, for additional equipment, and for extension of the communication and transportation systems.

Additional manpower is needed to obtain maximum effectiveness in the fire-control plan. This includes patrolmen, lookout men, and equipment operators. The additional cost of this extra personnel is approximately \$12,000.

Additional guard and ranger station improvements called for in the program on Federal lands include such items as barracks, cabins, barns, and water developments, with an initial installation cost of \$32,000. New equipment needs include hand tools, radios, pack stock, tanker trucks, and pick-ups, at an estimated initial cost of \$21,000. Annual operation and maintenance costs for structures and equipment will total \$5,500. Periodic replacement of various items is necessary at intervals of from 5 to 30 years; the average annual equivalent of the replacement costs is \$1,500.

Road, trail, and firebreak requirements for the proposed plan involve the reconstruction of 101 miles of existing roads at a cost of \$15,000, reconstruction of existing trails at a cost of \$5,000, building 162 miles of new tractor ways at a cost of \$135,000, and clearing 10 miles of firebreak at a cost of \$12,500. Annual operation and maintenance costs for these items will total \$3,900.

The plan as outlined is developed from a detailed study of fire history, weather records, and physical aspects of the area relating to the fire problem. The present defenses against fire form the basis for the measures proposed.

Cover improvement on burns.—An immediate first-aid treatment for large burns as they occur consists of sowing the fire-denuded areas with seeds of the mustard, which has proved to be the most effective plant for this purpose.⁸ Based on the frequency and area of expected large burns requiring such treatment during the 50-year period, the total estimated cost of this measure will be \$24,000.

Summary of costs.—In the following table are given the cash outlay and the average annual equivalent costs by items of the fire control and seeding of future burns recommended for the forest area of the watershed.

⁸ This measure is further described in appendix 6. This is the common black mustard, *Brassica nigra*.

TABLE 2.—*Summary of costs of forest land measures, plan I, Santa Ynez River watershed, California*

Item	Installation	Annual opera-tion and maintenance	Periodic re-placement ¹
Fire control:			
Land acquisition.....	\$16,000	0	0
Personnel.....	0	\$11,888	
Structures.....	32,260	963	\$15,288
Equipment.....	20,855	4,622	7,681
Roads, new.....	135,000	1,078	0
Roads, reconstruction.....	15,000	1,820	0
Firebreaks.....	12,500	1,000	0
Trails, reconstruction.....	5,000	0	0
Cover improvement: Seeding burns.....	4,425	420	9
Total.....	241,040	21,791	
Average annual equivalent.....	8,436	21,791	1,480

¹ At intervals varying from 5 to 30 years, according to the item considered.

Physical effects of the measures on forest land.—The recommended fire-prevention measures in aid of flood control will stabilize cover and soil conditions at high levels, permitting the fullest natural regulation of erosion and stream flow. Extreme fluctuations of conditions due to the recurrence of great fires will be arrested; the cover vegetation will attain a higher density and afford better protection to the soil on the mountain slopes; soil porosity and infiltration rates will be increased; and slope erosion losses will be greatly reduced. Flood peaks will be lowered, and dry season stream flow maintained for longer periods. Loss of water to the ocean will be decreased and replenishment of ground water supplies increased. Cover improvement through sowing of burned areas as they occur will reduce erosion during the first few years after burning.

Benefits from forest land measures in plan I.

A. Benefits in the event Gibraltar Dam is enlarged and no other reservoir built.—The measures recommended for the forest land will reduce sedimentation in Gibraltar Reservoir from the present average of 271 acre-feet a year to 48 acre-feet a year, and will thereby extend the useful life of the structure from an estimated 18 years to about 102 years. A similar benefit in reduced sedimentation rates will apply to the proposed enlargement of Gibraltar Dam, and its useful life would be extended from an estimated 160 years to more than 900 years. In Juncal Reservoir the sedimentation rate is expected to be reduced from 22 acre-feet annually to 4 acre-feet.

Average annual benefits from the reduction of sedimentation, based on the foregoing physical data, and the estimated value of an acre-foot of storage space of \$5.13 in Gibraltar and \$6.76 in Juncal, are as follows:

Gibraltar Reservoir.....	\$19,900
Juncal Reservoir.....	3,400
Total.....	23,300

In addition to the reduction of sedimentation, the forest-land measures will result in an average annual reduction in the cost of fire suppression of approximately \$19,600. Total average annual direct

evaluated benefits of the program on forest land are therefore estimated to be as follows:

Reduction in reservoir sedimentation-----	\$23,300
Reduction in fire suppression cost-----	19,600
Total-----	42,900

Average annual costs and benefits are as follows:

Average annual costs-----	\$30,225.00
Average annual benefits-----	42,900.00
Benefits per dollar of cost-----	1.40

In addition to these evaluated benefits the program on forest land would almost certainly produce some reductions in flood and sediment damage downstream from the enlarged Gibraltar Reservoir. The amount of such benefits would, of course, depend on the manner in which the reservoir was operated.

B. *Benefits in the event a dam is constructed at the Cachuma site and Gibraltar Dam is unchanged.*—Details on the construction and possible flood regulating effect of Cachuma Dam are not available. Based on the estimated construction cost and reservoir capacity of a tentative design for the Cachuma Dam,⁹ the cost of storage space in the reservoir would be approximately \$55 an acre-foot. For purposes of the present study it is assumed that this dam would be built in 1945, that it would be designed primarily for water conservation, but would probably regulate floods sufficiently to prevent a large part of the flood damage along the main stream. Under these conditions the flood-control benefits of the measures on forest land would be primarily reduction of sedimentation in Cachuma and Gilbraltar Reservoirs.

Future average annual deposition under continuation of the present level of protection was calculated for Gibraltar Reservoir at 271 acre-feet and for Juncal Reservoir at 22 acre-feet. For the 205 square miles of drainage area between the Cachuma dam site and Gibraltar Dam the sedimentation rate has been estimated at 800 cubic yards per square mile per year, making a total annual rate of 102 acre-feet. The rate of deposition in Cachuma Reservoir would increase after Gibraltar is filled. This increase is calculated to begin about 35 years hence, or 31 years after the assumed construction of Cachuma Dam in 1945. Deposition would increase over a period of 10 years until the full amount of debris from the Gibraltar watershed would be carried over the debris-filled Gibraltar Reservoir and added to the deposition from the Cachuma watershed, increasing the rate by 271 acre-feet a year. Average deposition in Cachuma Reservoir would thus become 373 acre-feet a year, beginning 10 years after Gibraltar is filled.

Under the higher level of fire protection proposed in this plan the Gibraltar deposition rate is calculated at about 48 acre-feet and in Juncal at about 4 acre-feet a year. The rate for Cachuma is estimated at about 51 acre-feet a year until Gibraltar Reservoir is filled with debris. It is calculated that, with the program installed on forest land, Gibraltar Reservoir will be filled with debris about 170 years after 1945, the assumed date of construction of Cachuma Dam.

⁹ Report of Quinton, Code & Hill-Leeds & Barnard, consulting engineers, 1939, Utilization of Water Resources in Southern Portion of Santa Barbara County.

Average annual equivalent benefits from the reduction of sedimentation, based on the foregoing physical data, a value of an acre-foot of storage space (when received) of \$5.13 in Gibraltar and \$6.76 in Juncal, and a construction cost of \$55 an acre-foot for Cachuma Reservoir are as follows:¹⁰

Gibraltar Reservoir-----	\$18,900
Juncal Reservoir-----	3,400
Cachuma Reservoir-----	7,900
Total-----	30,200

In addition to these benefits the average annual saving in fire-suppression cost under the proposed forest-land program is estimated at about \$19,600.

Total average annual direct evaluated benefits of the program on forest land are therefore estimated to be as follows:

Reduction in reservoir sedimentation-----	\$30,200
Reduction in fire-suppression cost-----	19,600
Total-----	49,800

Average annual costs and benefits are as follows:

Average annual costs-----	\$30,225.00
Average annual benefits-----	49,800.00
Benefit per dollar of cost	1.65

C. Benefits in the event a dam is constructed at the Cachuma site and Gibraltar Dam enlarged.—Without better protection of the forest cover, sedimentation in enlarged Gibraltar Reservoir is expected to proceed at the rate of about 271 acre-feet a year. The useful life of the reservoir would be 160 years, allowing for 3,500 acre-feet of required minimum storage capacity. Sediment would begin to pass Gibraltar Dam into the Cachuma drainage after about 175 years.

With the proposed protection program, sedimentation in Gibraltar Reservoir would be at the rate of about 48 acre-feet a year, and the useful life would be prolonged over 900 years. Sediment would begin to pass the dam about 1,000 years after its construction.

Sedimentation of Cachuma Reservoir under the present degree of watershed protection would proceed at the average rate of 102 acre-feet a year until the time when debris would begin to pass Gibraltar Dam. Allowing 10 years for the Gibraltar debris contribution to reach its full amount, a total of 373 acre-feet a year would enter Cachuma Reservoir, beginning about 180 years after its construction. A further slight increase in the deposition rate would be felt after Juncal Reservoir became filled with debris.

With the proposed protection program, deposition in Cachuma Reservoir is expected to be about 51 acre-feet a year, and to increase after 1,000 years to about 100 acre-feet when the enlarged Gibraltar Dam would be filled.

Savings in reservoir storage capacity through installation of the forest land program are calculated at an average annual equivalent value of \$19,900 in the enlarged Gibraltar Reservoir, and at about \$2,800 in Cachuma Reservoir. These figures are derived by applying the foregoing physical data to the value of an acre-foot of storage space (when received) of \$3.09 in enlarged Gibraltar Reservoir, and

¹⁰ Appendix 3.

to the assumed construction cost of \$55 an acre-foot for Cachuma Reservoir. Total average annual benefits from the reduction of reservoir sedimentation are therefore:

Enlarged Gibraltar Reservoir-----	\$19,900
Juncal Reservoir-----	3,400
Cachuma Reservoir-----	2,800
Total-----	26,100

Total average annual direct evaluated benefits of the program on forest land are therefore estimated to be as follows:

Reduction in reservoir sedimentation-----	\$26,100
Reduction in fire-suppression cost-----	19,600
Total-----	45,700

Average annual costs and benefits are as follows:

Average annual costs-----	\$30,225.00
Average annual benefits-----	45,700.00
Benefit per dollar of cost-----	1.51

2. Structural measures on tributary channels and supporting land-use measures.¹¹

Structural measures are recommended for tributary channels on the north side of the Santa Ynez River, extending from Purisima Canyon to Canada de Laguna. These channels are deeply entrenched in long, narrow bottom lands. Severe gully and sheet erosion is evident on many of the hillsides and along minor drainage ways. The most serious problem exists near the lower ends of most of the drainages where the land is subject to overflow and sediment deposition. Some 2,000 acres of productive farm land are in this category. Since the chief cause of the excessive erosion and deposition is misuse of the land, a large part of the corrective program must consist of cropland treatment.

Proposed structural measures include grassed waterways, terraces, terrace outlets, and check dams. Other necessary measures are the clearing of debris from channels, construction of new channels, and the sloping and planting of gully banks.

Structural measures are proposed on the south side of the Santa Ynez River for the protection of farm land that is periodically damaged by inundation and deposition from Rodeo, San Pasqual, and San Miguelito Creeks. The necessary work includes cleaning and enlargement of existing channels and the construction of some additional channels, levees, culverts, and bridges.

The estimated installation cost of structural measures on both sides of the river is \$181,000. Of this amount \$177,500 should be paid from Federal funds and \$3,500 from other public funds.

In the areas on the north side of Santa Ynez River from Purisima Canyon to Canada de Laguna (areas A7 and B1 as shown on map 2) the structural measures will need to be supported by certain changes in cultural practices and rotations, and the seeding of eroding cropland to grasses.

¹¹ Described in detail in appendix 4.

The average annual cost of the structural measures in areas A7 and B1 is \$6,858; in area A3 (west of Lompoc), \$1,510.

The average annual equivalent of increased operating cost to farmers for areas A7 and B1 is \$17,536.

The Federal Government should supply funds to seed the eroding cropland and should furnish technical assistance to farmers in carrying out the program. Seeding would require an initial outlay of \$1,997 or an average annual equivalent of \$70. Technical assistance during the first 10 years of program operation would require a cash outlay of \$10,457 or an average annual equivalent of \$320. Cost for adjusting machinery is negligible.

Benefits of structural and supporting land-use measures.—It is estimated that the structural measures to be applied to the canyons north of Santa Ynez River, together with supporting land-use measures, will reduce annual sedimentation damages by \$12,500, and loss of land through erosion by \$1,100, and thus produce a total of \$13,600 of flood and sediment-reduction benefits. In addition, an average annual increase of \$86,600 in gross income to farmers is expected to be produced.

Damages on the tributaries southwest of Lompoc, amounting to \$2,400 on the average annually, would be virtually all eliminated by the proposed program of structural measures.

Average annual costs and benefits of structural measures and supporting land-use measures are shown in table 3.

TABLE 3.—*Average annual cost and benefits for land-use and structural measures in areas A7, B1, and A3; plan I*

Measures	Average annual cost			Average annual benefits		
	Public	Private	Total	Reduction in local flood dam- age	Conserva- tion	Total
Areas A7, B1:						
Land use-----	\$390	\$17,536	\$17,926		\$86,639	\$86,639
Structural-----	5,608	1,250	6,858	\$13,634		13,634
Total-----	5,998	18,786	24,784	13,634	86,639	100,273
Area A3: Structural-----	1,502	8	1,510	2,412		2,412

PLAN II

Plan II is recommended for installation in the event reservoir storage is provided according to either of the following arrangements:

1. A dam constructed at the Santa Rosa site and Gibraltar Dam enlarged.

2. Dams constructed at the Cachuma and Santa Rosa sites and Gibraltar Dam unchanged.

Plan II consists of three parts: (1) Additional fire control and cover improvement measures on the forest land, identical to that proposed under plan I; (2) a farm-land treatment program plus local structures in areas upstream from Santa Rosa Dam; and (3) structures to reduce local damages caused by streams in Purisima, Cebada, Hoag, Santa Rita, San Miguelito, San Pasqual, and Rodeo Canyons, supplemented by land-use measures in the area drained by Purisima, Cebada, Hoag, and Santa Rita Canyons.



LEGEND

- Watershed Boundary
- - Subwatershed Boundary
- Area Boundary and Number
- Santa Ynez River

MAP-2
SUBDIVISIONS
SANTA YNEZ RIVER WATERSHED
CALIF.

Scale: $1/4"$ = 1 mile

The benefits from parts 1 and 2 of this plan will vary according to which combination of reservoirs is adopted.

1. Measures on forest land.

Measures on forest land are the same as those proposed under plan I, except that some additional improvements will be installed farther downstream at a cost of \$4,845, with additional maintenance costs of \$380 or a total initial cost of \$245,885 and maintenance of \$22,171.

2. Farm land treatment measures plus local structures upstream from Santa Rosa Dam.¹²

The farm land treatment program includes changes in rotations, cultural practices, and retirement of eroding cropland to grazing use.

The average annual values of increased operating cost to farmers for the area above Santa Rosa Dam site are given below:

Area	Acres	Acres treated	Average annual increased operating cost
B1	8,623	6,808	\$3,700
B2	5,981	2,185	6,350
B6	4,313	2,146	9,633
C3	17,776	15,213	55,125
Total			74,808

The Federal Government will supply funds to seed cropland for conversion to grazing use and will also furnish technical assistance to the farmers in carrying out the program. Seeding the necessary areas above Santa Rosa Dam site would require an outlay of \$9,720 or an average annual cost of \$340. For technical assistance during the first 10 years of program operation would require an outlay of \$23,830 or an average annual cost of \$730.

Public agencies other than Federal will be expected to supply funds for creating a machinery pool and for modifying existing machinery. The needed amount for the area above Santa Rosa Dam site is \$9,922, which has an average annual value of \$347.

The structural program for the area above Santa Rosa Dam site involves construction of terraces, head-cut controls, check dams, diversion dams, channels and grassed waterways. This program requires an investment of \$28,667 in Santa Rosa Valley and of \$1,650 in Canada de los Palos Blancos. The average annual values are \$1,004 and \$57, respectively. These funds will be supplied by the Federal Government.

Operation and maintenance cost of the structural program will be paid for by farmers and by public agencies other than Federal. For Santa Rosa Valley the average annual amount would be \$394, with \$146 paid from public funds and \$248 by farmers. In Canada de los Palos Blancos the amounts are \$7 public funds and \$20 farmers' funds, or a total of \$27 a year.

3. Structures to reduce local damages below Santa Rosa Dam site, supplemented by land use measures north of Santa Ynez River.

The farm land program in support of structures in areas A-7 and the portion of B-1 below Santa Rosa Dam site includes changes in

¹² More detail on these measures and their costs is contained in appendix 4.

cropping and cultural practices and the seeding of eroding cropland to grasses. The average annual cost to farmers is \$13,800. The cost of seeding grass requires an outlay of \$1,330 or an average annual cost of \$47, which will be paid from Federal funds. Technical assistance to farmers which also will be paid from Federal funds will amount to about \$7,000 for the required 10-year period. This expressed as an average annual value is \$226. Requirements for adjustment of machinery are negligible.

Structural measures for the areas below Santa Rosa Dam are similar in nature to those above the dam except that structures in San Miguelito, San Pasqual, and Rodeo Canyons are unsupported by a farm land program.

Average annual cost of the program is \$6,886 as shown in table 4.

TABLE 4.—*Summary of cost of structural measures below Santa Rosa Dam site, plan II¹*

Canyons	Installation cost				Operation and maintenance average annual			Total cost (average annual)
	Federal cash outlay	Other public cash outlay	Total cash outlay	Average annual equivalent	Other public	Private	Total	
Purisima and Cebada.....	\$60,263	-----	-\$60,263	\$2,108	\$252	\$557	\$809	\$2,917
Hoag and Santa Rita.....	50,435	-----	-50,435	1,767	267	425	692	2,459
San Miguelito, San Pasqual and Rodeo.....	36,410	\$3,520	39,930	1,398	104	8	112	1,510
Total.....	147,108	3,520	150,628	5,273	623	990	1,613	6,886

¹ Details are to be found in tables 38 and 39 of appendix 4 and table 5 of appendix 7.

BENEFITS OF THE PROGRAMS IN PLAN II.

1. Benefits from the measures to be installed above Santa Rosa Dam site

(a) *Benefits in the event a dam is constructed at Santa Rosa Dam site and Gibraltar Dam enlarged.*—Since construction plans and estimates for Santa Rosa Dam are not available the value of storage space in the reservoir was assumed at \$70 per acre-foot.

The benefits derived from the forest-protection program above enlarged Gibraltar Dam, including the Juncal drainage area, have been described in plan I. Their average annual value is approximately \$23,300. Benefits in the form of sedimentation reduction for Santa Rosa Reservoir have been calculated as follows:

Without intensified forest-land protection, average annual sedimentation at the Cachuma site would be 102 acre-feet, and would reach 373 acre-feet about 180 years from 1945 when Gibraltar is filled. With the program the sedimentation rate would be reduced to 51 acre-feet a year and would increase to 100 acre-feet a year after Gibraltar Reservoir is filled about 1,000 years hence.

For the area between the Cachuma and Santa Rosa Dam sites it was estimated that with continuation of the present forest-land protection and farming practices the rate would be 96 acre-feet a year.

This was calculated from the following forest, range, and cropland estimates:

1. On about 30 square miles of forest land below Cachuma Dam site, the rate was estimated at 1,500 cubic yards per square mile a year. This is based on field examinations and comparison with conditions of similar drainages for which rates of debris movement are known.
2. On approximately 200 square miles of grazing land, sediment contributions are between 2,000 to 2,500 cubic yards per square mile each year, averaging about 2,200 cubic yards.

When the proposed measures are installed, sedimentation contribution to Santa Rosa Dam from this area would be reduced to about 18 acre-feet per year.

Total sediment contribution to Santa Rosa Dam, without the program during the first 100-year period, would combine the 102 acre-feet at Cachuma site with the 96 acre-feet for the area below Cachuma to make a total rate of about 198 acre-feet a year. With the remedial program in effect the rate would be reduced to 69 acre-feet a year, or an annual reduction of approximately 129 acre-feet. With cost of the dam at \$70 an acre-foot the average savings would be \$9,030 per year throughout the first 100-year period.

Reductions in fire-suppression cost are estimated at \$19,600.

The cropland program for the area above Santa Rosa Dam site would benefit farmers by increasing their gross farm income. The average annual value of these benefits is \$147,900, distributed by areas as shown below:

Area:	Average annual equivalent value of increased gross returns
B1	\$20, 910
B2	10, 660
B6	14, 287
C3	102, 069
Total	147, 926

The structural measures in Santa Rosa Canyon and Canada de los Palos Blancos would eliminate local flood damages in addition to reducing sediment contribution to Santa Rosa Reservoir. Loss of land by bank cutting and sedimentation of cropland that would occur without these measures is serious. Elimination of these damages would produce an average annual equivalent benefit of about \$1,902 in the Santa Rosa Valley and \$2,773 in Canada de los Palos Blancos, or a total of approximately \$4,700.

Average annual direct evaluated benefits are therefore estimated to be as follows:

Reduction in reservoir sedimentation	\$32, 300
Reduction of local flood and sediment damage	4, 700
Total flood-control benefits	37, 000
Increase in gross farm income	147, 900
Reduction in fire-suppression cost	19, 600
Total benefits	204, 500

Average annual costs and benefits are as follows:

Average annual costs.....	\$110,000.00
Average annual benefits.....	204,500.00
Benefit per dollar of cost.....	1.86
Average annual Federal cost.....	34,500.00
Average annual flood-control benefit.....	37,000.00
Flood-control benefit per dollar Federal cost.....	1.08

(b) *Benefits in the event dams are constructed at Santa Rosa and Cachuma sites and Gibraltar Dam is unchanged.*—Benefits from the reduction of sedimentation in Gibraltar, Juncal, and Cachuma Reservoirs is the same as under plan I, namely, \$30,200.

Reduction in sediment contribution from the area between the Cachuma and Santa Rosa Dam sites was previously discussed under (a). Sedimentation in Santa Rosa Reservoir from this area, without the proposed program, was calculated at the average annual rate of 96 acre-feet; and with the program at 18 acre-feet. The annual benefit would be 78 acre-feet. With an assumed value of storage space in Santa Rosa Reservoir of \$70 an acre-foot, the average annual benefits for the first 100-year period would be \$5,460.

Local flood and sediment-reduction benefits, benefits from reduced fire-suppression cost, and benefits from increased gross farm income are the same as they would be if Cachuma Dam were not constructed.

Average annual direct evaluated benefits are therefore estimated as follows:

Reduction in reservoir sedimentation.....	\$35,600
Reduction of local flood and sediment damage.....	4,700
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Total flood-control benefits.....	40,300
Increase in gross farm income.....	147,900
Reduction in fire-suppression cost.....	19,600
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Total benefits.....	207,800

Average annual costs and benefits are as follows:

Average annual costs.....	\$110,000.00
Average annual benefits.....	207,800.00
Benefit per dollar of cost.....	1.89
Average annual Federal cost.....	34,500.00
Average annual flood-control benefit.....	40,300.00
Flood-control benefit per dollar Federal cost.....	1.17

2. Benefits from the measures to be installed below Santa Rosa Dam site.

The cropland program in the area below Santa Rosa Dam in addition to supporting structural measures in Purisima, Cebada, Hoag, and Santa Rita Canyons would benefit farmers by increasing their gross farm income. The average annual value of these benefits is \$65,730.

Structural works proposed and the benefits to be derived from them in Purisima, Cebada, Hoag, and Santa Rita Canyons below Santa Rosa Dam site on the north side of Santa Ynez River, and in San Miguelito, San Pasqual, and Rodeo Canyons on the south side of Santa Ynez River have been described. The average annual benefits from reduction of local flood damage are as follows:

Purisima and Cebada canyons.....	\$6,283
Hoag and Santa Rita canyons.....	2,676
San Miguelito, San Pasqual, and Rodeo Canyons.....	2,412
<hr/>	
Total.....	11,371

Average annual direct evaluated benefits are therefore estimated to be as follows:

Reduction in local flood and sedimentation damage-----	\$11,400
Increase in gross farm income-----	65,700
Total-----	77,100

Average annual costs and benefits are as follows:

Average annual costs-----	\$21,000.00
Average annual benefits-----	77,100.00
Benefit per dollar of cost-----	3.68
Average annual Federal cost-----	5,250.00
Average annual flood-control benefit-----	11,400.00
Flood-control benefit per dollar Federal cost-----	2.16

Period of the program.—It is expected that most installations recommended will be completed during the first few years of the program, and that little time will be lost in obtaining their full effect. Operation, maintenance, and replacement were calculated to continue for an infinite period of time, except in cases where measures are of a supporting nature to other programs and their maintenance may be discontinued earlier.¹³

Cash outlays required for installation, average annual cost of operation, maintenance, and replacement, and average annual costs and benefits of the alternative programs are given in table 1.

Sources of funds.—Installation: Installation costs will be borne by public agencies or governments. The fire program will be financed by the Federal Government and carried out by the Forest Service. Installation expenditures for the purchase and modification of machinery in connection with the farm-land-treatment program will be obtained from the county or other agencies through the local soil-conservation district. Seeding of converted cropland will be financed by the Federal Government.

Operation, maintenance, and replacement: Operation and maintenance cost of the fire program will be met entirely from Federal funds. Replacement costs also will be borne by the Federal Government. Yearly requirements are shown in table 2.

The cost for facilitating personnel will be borne by the Federal Government.

Operation and maintenance costs to farmers for the first 50 years for the farm-land program would be approximately \$6,686,400 at a yearly rate of about \$134,000. The Federal Government should contribute \$36,600 during the first 50 years, most of which is for facilitating personnel, an expenditure to be made during the first 10 years of the program.

¹³ See appendix 4, table 39.





